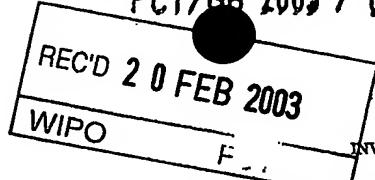




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3. Full name, address and postcode of the or of each applicant <i>(underline all surnames)</i>	De La Rue International Limited De La Rue House Jays Close Viables Basingstoke  7283609002		
Patents ADP number <i>(if you know it)</i>			
If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom		
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5. Name of your agent <i>(if you have one)</i>	BOULT WADE TENNANT		
"Address for service" in the United Kingdom to which all correspondence should be sent <i>(including the postcode)</i>	VERULAM GARDENS 70 GRAY'S INN ROAD LONDON WC1X 8BT		
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Claim(s) 3

Abstract

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IMPROVEMENTS IN METHODS OF MANUFACTURING SUBSTRATES

The present invention relates to improvements in methods of manufacture of substrates which can be used in varying shapes and sizes for various authenticating or security applications, which combine the advantages of indicia formed from metallisation or demetallisation of a security element and the colourshift effects of liquid crystal materials.

The increasing popularity of colour photocopies and other imaging systems and the improving technical quality of colour photocopies has led to an increase in the counterfeiting of bank notes, passports and identification cards etc. There is, therefore, a need to add additional authenticating or security features to existing features. Steps have already been taken to introduce optically variable features into such documentation which cannot be reproduced by a photocopier. There is also a demand to introduce features which are discernible by the naked eye but which are "invisible" to, or viewed differently, by a photocopier. Since a photocopying process typically involves scattering high energy light off an original document containing the image to be copied, one solution would be to incorporate one or more features into the document which have a different perception in reflected and transmitted light, an example being watermarks and enhancements thereof.

It is known that certain liquid crystal materials exhibit a difference in colour when viewed in transmission and reflection as well as an angularly dependent coloured reflection. Liquid crystal materials have been incorporated into documents, identification cards and other security elements with a view to creating distinctive optical

characteristics. EP-A-0435029 is concerned with a data carrier, such as an identification card, which comprises a liquid crystal polymer layer or film in the data carrier. The liquid crystal polymer is in solid form at room temperature and is typically within a laminate structure. The intention is that the liquid crystal layer, which is applied to a black background, will demonstrate a high degree of colour purity in the reflected spectrum for all viewing angles. Automatic testing for verification of authenticity is described using the wavelength and polarisation properties of the reflected light in a single combined measurement. This has the disadvantage of being optically complex using a single absolute reflective measurement requiring a uniform liquid crystal area on a black background. AU-488,652 is also concerned with preventing counterfeit copies by introducing a distinctive optically-variable feature into a security element. This patent discloses the use of a liquid crystal "ink" laminated between two layers of plastic sheet. The liquid crystal is coated on a black background so that only the reflected wavelengths of light are seen as a colour. The patent is primarily crystals which have the characteristic of changing colour with variation in temperature.

Cholesteric liquid crystals have certain unique properties in the chiral nematic phase. It is the chiral nematic phase which produces an angularly dependent coloured reflection and a difference in colour when viewed in either transmission or reflection. Cholesteric liquid crystals form a helical structure which reflects circularly polarised light over a narrow band of wavelengths. The wavelength is a function of the pitch of the helical structure which is formed by alignment within the liquid crystal material. An example of such a structure is depicted

in Fig.1 with the cholesteric helical axis in the direction of the arrow X. The reflection wavelength can be tuned by appropriate choice of chemical composition of the liquid crystal. The materials can 5 be chosen to be temperature sensitive or insensitive. Both handednesses of circularly polarised light can be reflected by choice of the correct materials and thus high reflectivities at specific wavelengths can be achieved with double layers of liquid crystals. The 10 wavelength of reflected light is also dependent on the angle of incidence, which results in a colour change perceived by the viewer as the device is tilted (Fig.2).

15 On a dark background, only the reflective effect is observed, since little light is being transmitted from behind. When the dark background is removed or not present and the device is viewed in transmission, the intensity of the transmitted colour swamps the 20 reflective colour.

Of the light which is not reflected, a small proportion is absorbed and the remainder is transmitted through the liquid crystal material 3. 25 When correctly configured there is a dramatic change between the transmitted colour in the direction of arrow Y and reflected colour in the direction of arrow Z (Fig.3). The region on either side of the liquid crystal layer 3 in Fig.3 is a transparent polymer or glass. To achieve this effect the area of the 30 substrate which is occupied by the liquid crystal must be transparent or translucent. The transmitted and reflected colours are complementary, for example, a green reflected colour produces a magenta transmitted 35 colour.

In the field of banknotes, and security elements or threads in particular, the use of demetallised indicia such as described in EP-A-319157 has proved to be highly effective in reducing counterfeiting.

5 However, in the security business it is always advantageous to continually strive to find new and further improved anti-counterfeit security features.  
It is desired to use the highly advantageous characteristics of demetallised characters and colour  
10 shift effects from liquid crystal materials.

According to the invention there is provided a method of manufacturing a substrate comprising the steps of applying a darkly coloured resist to at least a part of a metallic layer on one side of a substantially transparent polymeric film, removing metal from areas not covered by the resist to form demetallised regions and applying a polymeric liquid crystal material over the resist and the demetallised  
15 regions.  
20

The invention also provides a substrate made by this method.

25 A preferred embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

30 Fig. 1 depicts chiral nematic alignment of a cholesteric liquid crystal material;

Fig. 2 shows how the reflection from a cholesteric liquid crystal material varies with the angle of incidence;

35 Fig. 3 depicts the transmission and reflection of light incident on a liquid crystal material;

Figs. 4 and 5 are cross sections across the width of two alternate elongate authenticating device formed by the present invention; and

5 Fig. 6 is a plan view of the elongate authenticating device of Fig. 5.

Figs. 1 to 3 have already been described in detail as background to the present invention.

10 Referring now to Fig. 4, there is illustrated a substrate 10 formed by the method of the present invention for use in security or authenticating devices. The method requires a metallised film comprising a substantially clear polymeric film 11 of PET or the like, which has an opaque layer of metal 12 on a first side thereof. A suitable pre-metallised film is metallised MELINEX<sup>S</sup> film from DuPont<sup>®</sup> of preferably 19 $\mu\text{m}$  thickness.

20 The metal layer 12 is printed with a resist 13 which contains a black or dark dye or pigment. Suitable resists include the dye BASF Neozapon X51 or the pigment (well dispensed) carbon black 7 mixed into a material with both good adhesion to metal and caustic resistance. The dye loading can be up to 50% (by weight) of the final coat of resist 13 depending on coat thickness and desired blackness. An example of a class of suitable resist materials is vinyl chlorides/vinyl acetate copolymers such as Union Carbide Ucar resins, Sun VHL 31534, or Wacker Vinnol E 15/45m. The metallised film is then partially demetallised, according to a known demetallisation process using a caustic wash which removes the metal in the regions not printed with the resist 13. The remaining regions coated with resist 13 provide a black layer which is visible when the demetallised

film is viewed from its first side (along arrow Y) interspersed with clear regions. The shiny metal of the remaining parts of the metallic layer 12 are only visible from an opposite side of the demetallised film  
5 (along arrow X). The resist 13 may be printed in the form of the indicia 14 (see figure 6) such as words, numerals, patterns and the like; in which case the resulting indicia 14 will be positively metallised, with the metal still covered by the dark or black  
10 resist 13. Alternatively the resist 13 may be printed so as to form indicia negatively, in which case the resulting indicia 14 will be provided by the demetallised regions. The indicia 14, however formed, are clearly visible from both sides,  
15 especially in transmitted light, due to the contrast between the regions of the metal which have been removed and the remaining opaque regions.

A layer 15 of polymeric liquid crystal material  
20 is then coated, transferred or laminated to the demetallised film over the remaining parts of the black resist layer 13 and the demetallised regions. A layer of a suitable adhesive 16 may be required, for this process, applied between the black resist layer  
25 13 and the liquid crystal layer 15. This has the effect of producing a highly visible colour shift effect when the finished substrate 10 is viewed in reflection from the first side (along arrow Y); and a metallic shiny partial coating when viewed from the  
30 other side (along arrow X). Additionally clear positive or negative indicia 14 can be seen in transmission from either side.

When the aforementioned substrate 10, or a strip  
35 or thread made therefrom, is included in paper, the remaining metal of layer 12 is not actually visible, as it is hidden either by the masking coat of resist

13 or the paper. However, it does add opacity, thereby enhancing the contrast between the demetallised and metallised areas, and the black of the resist layer 13 appears darker on it, since there  
5 is no transmitted light through to the layer 13.

If a metallic effect is not desired, an additional masking coat may be used as well as the black layer of resist 13 and a suitable material for such a masking coat would be Coates 3188XSN or Coates 10 Heliovyl White S90 353. A typical coat weight is suggested to be in the region of 2GSM.

Whilst the use of a black, or very dark dye, may give rise to the most strong colour shift effects, other effects may be generated by the use of a dyed resist of other colours or a combination of colours giving rise to differing apparent colour shift colours.

20 Optionally, a further protective layer 17 may be laminated to or coated over the liquid crystal layer 15. Such a layer 17 may be a PET laminate or an anti-scratch coating. A suitable anti-scratch coating 25 would be Wacker Vinnol E 15/45M.

The black dye or pigment in the resist 13 may be a conducting material, such as carbon black, to produce a machine-readable conducting layer.

30 Alternatively it may be a magnetic material, such as magnetite, to produce a machine readable magnetic layer.

In a further embodiment of the invention shown in 35 Fig. 5, only some parts of the layer of resist 13 contain a dark dye or pigment and some parts 18 are

substantially clear containing low concentrations of, or no, dye/pigment. When viewed from the first side (along arrow Y), the metal of the metallic layer 12 can clearly be seen in the regions of remaining clear  
5 resist 18, unaffected by the liquid crystal layer 17. The colourshift effect can only be seen in the darkly coloured resist regions 13. This is shown in Fig. 6.

10 The clear resist regions 18 may also contain a fluorescent, luminescent or phosphorescent material so that, whilst the metallic layer 12 can be seen as metallic in normal lighting in those regions, under UV lighting the regions 18 have a definite colour.

15 Additionally, in the regions 18 where the metal is visible under the clear resist 18 a holographic structure can be incorporated into the metallic layer.

20 Another effect provided by the invention is that, when viewed off-axis, the colour of the liquid crystal changes slightly as the substrate 10 is rotated. When the substrate is overcoated with an adhesive or anti-scratch coating the colour change is reduced. Thus, if the adhesive/anti-scratch coating is applied in the  
25 form of a pattern or design, then the coated/uncoated regions can appear as different colours off-axis. When the uncoated regions change colour on movement of the element 10 the contrast is seen more clearly.

30 Another effect which can be usefully used is that, when the substrate 10 is stretched, it changes colour (irreversibly). The colour goes to longer wavelengths (eg green goes to red) and retains its colour shifting capability (eg red now goes to green  
35 off-axis).

The use of fluorescent, luminescent or

phosphorescent materials in the clear parts 18 of the layer of resist 13 enable interesting effects to be produced.

5       The substrate 10 produced by this method can be slit or cut into patches, foils, stripes, strips or threads for incorporation into plastic or paper substrates in accordance with known methods. Whilst these are preferably partially embedded into a paper 10 or plastic substrate, they may be applied to a substrate or wholly embedded within.

CLAIMS:

1. A method of manufacturing a substrate comprising the steps of applying a darkly coloured resist to at least a part of a metallic layer on one side of a substantially transparent polymeric film, removing metal from areas not covered by the resist to form demetallised regions and applying a polymeric liquid crystal material over the resist and the demetallised regions.
2. A method as claimed in claim 1 in which the resist contains a black or dark dye or pigment.
- 15 3. A method as claimed in claim 1 or claim 2, further comprising the step of applying a substantially clear resist to at least another part of the metallic layer.
- 20 4. A method as claimed in any one of the preceding claims in which the demetallisation process comprises washing the substrate with a caustic wash.
- 25 5. A method as claimed in any one of the preceding claims in which negative indicia are formed by the demetallised regions.
- 30 6. A method as claimed in any one of claims 1 to 4 in which positive indicia are formed by the resist covered regions.
- 35 7. A method as claimed in any one of the preceding claims in which the polymeric liquid crystal layer is applied by a coating process.
8. A method as claimed in any one of claims 1 to 6 in which the polymeric liquid crystal layer is applied

by a transfer process.

9. A method as claimed in any one of claims 1 to 6  
in which the polymeric liquid crystal layer is applied  
5 by lamination.

10. A method as claimed in any one of the preceding  
claims in which the resist incorporates a conducting  
material to produce a machine-readable conducting  
10 layer.

11. A method as claimed in any one of the preceding  
claims in which the resist incorporates a magnetic  
material to produce a machine readable magnetic layer.  
15

12. A method as claimed in any one of the preceding  
claims in which the resist comprises a plurality of  
different colours.

20 13. A method as claimed in any one of the preceding  
claims in which a holographic structure is  
incorporated into the metallic layer.

25 14. A method as claimed in any one of the preceding  
claims in which fluorescent, luminescent and/or  
phosphorescent material is incorporated in the resist.

30 15. A method as claimed in claim 13 in which a  
fluorescent, luminescent and/or phosphorescent  
material is incorporated in the clear resist.

16. A substrate formed by the method of any one of  
the preceding claims.

35 17. A patch, foil, stripe, strip or thread formed  
from the substrate of claim 15.

18. A method substantially as hereinbefore described with reference to the accompanying drawings.

19. A substrate substantially as hereinbefore  
5. described with reference to and as shown in the  
accompanying drawings.

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FIG. 1.

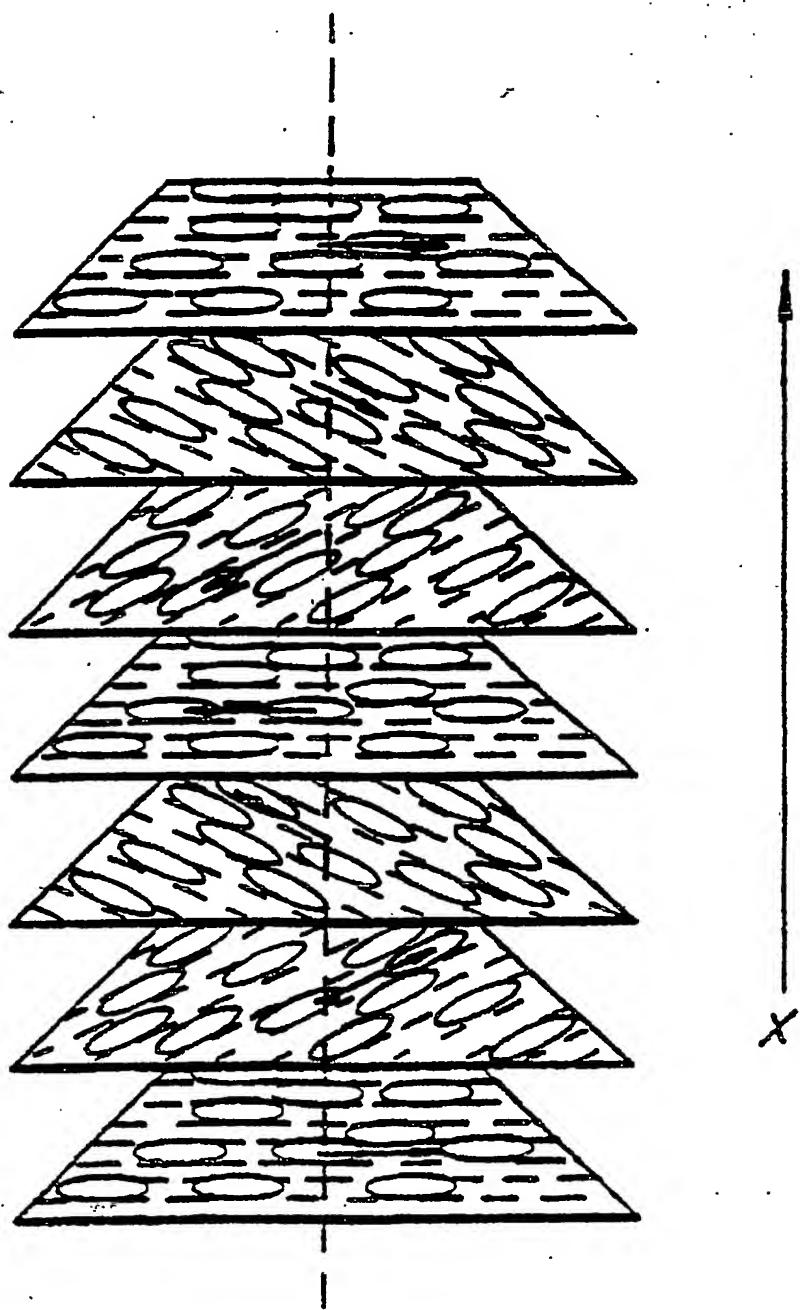
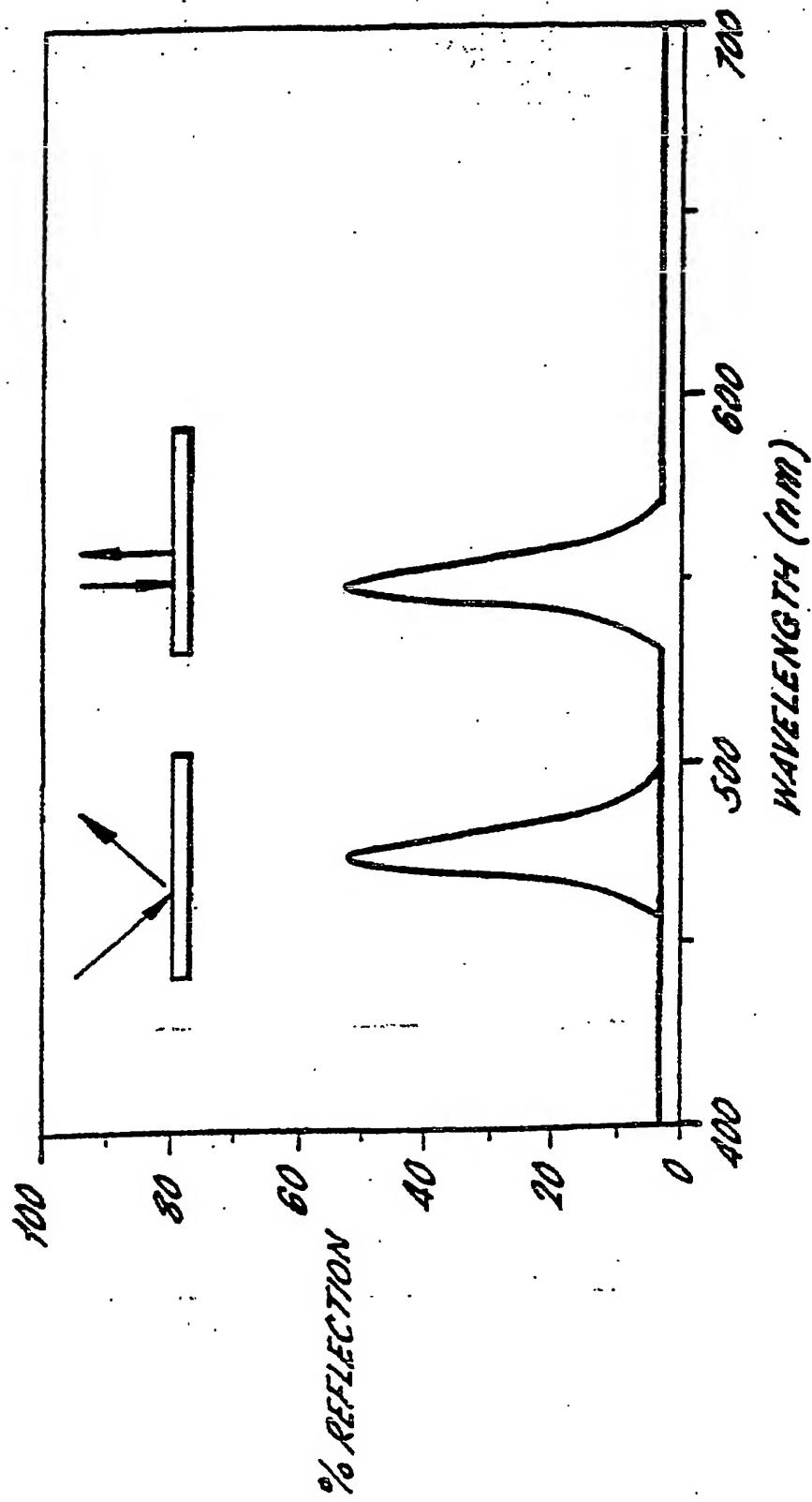
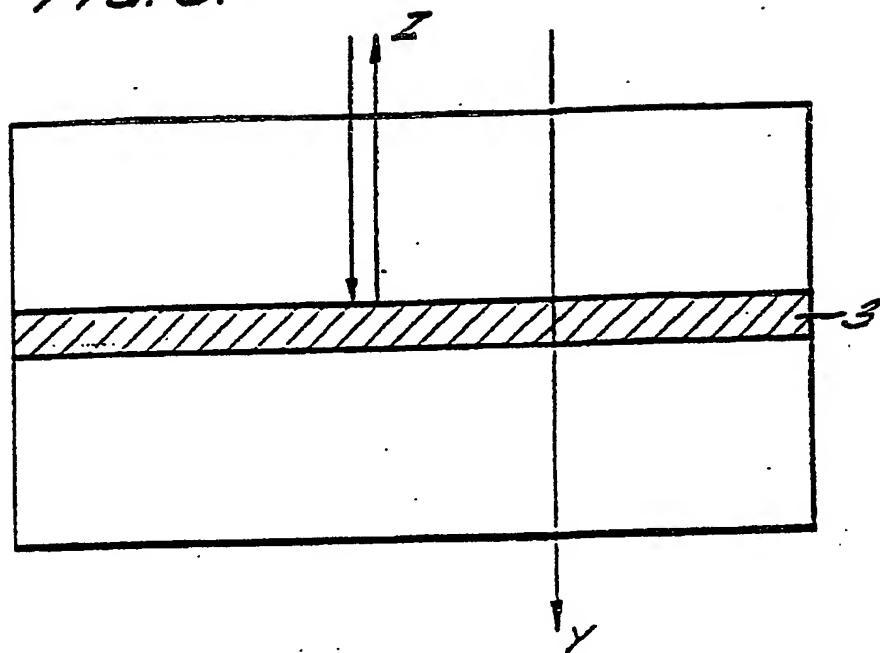


FIG. 2.



3/4

FIG. 3.



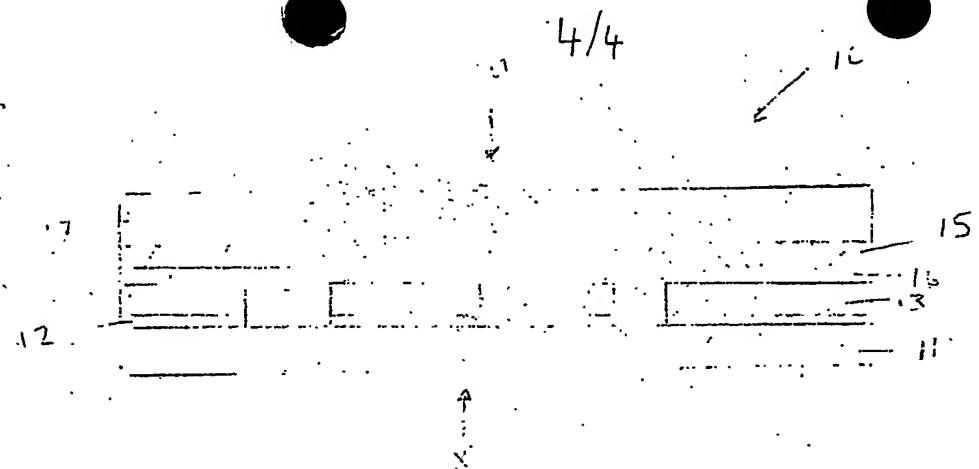


FIGURE 4

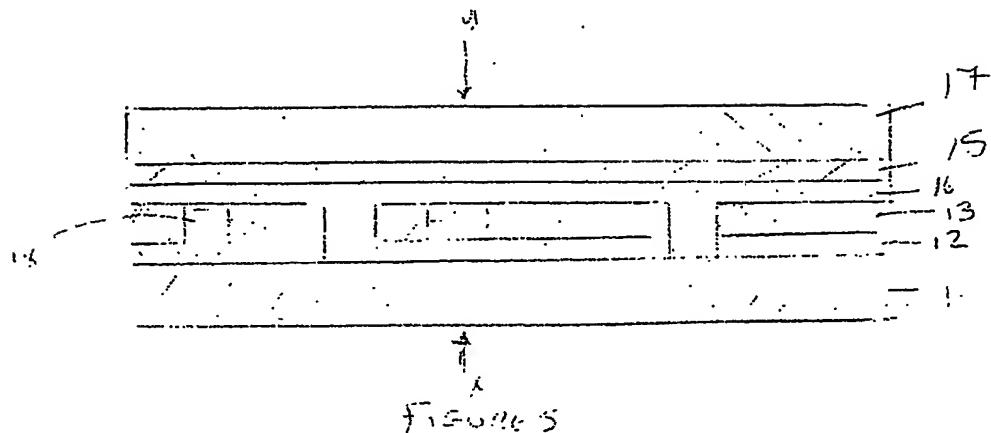
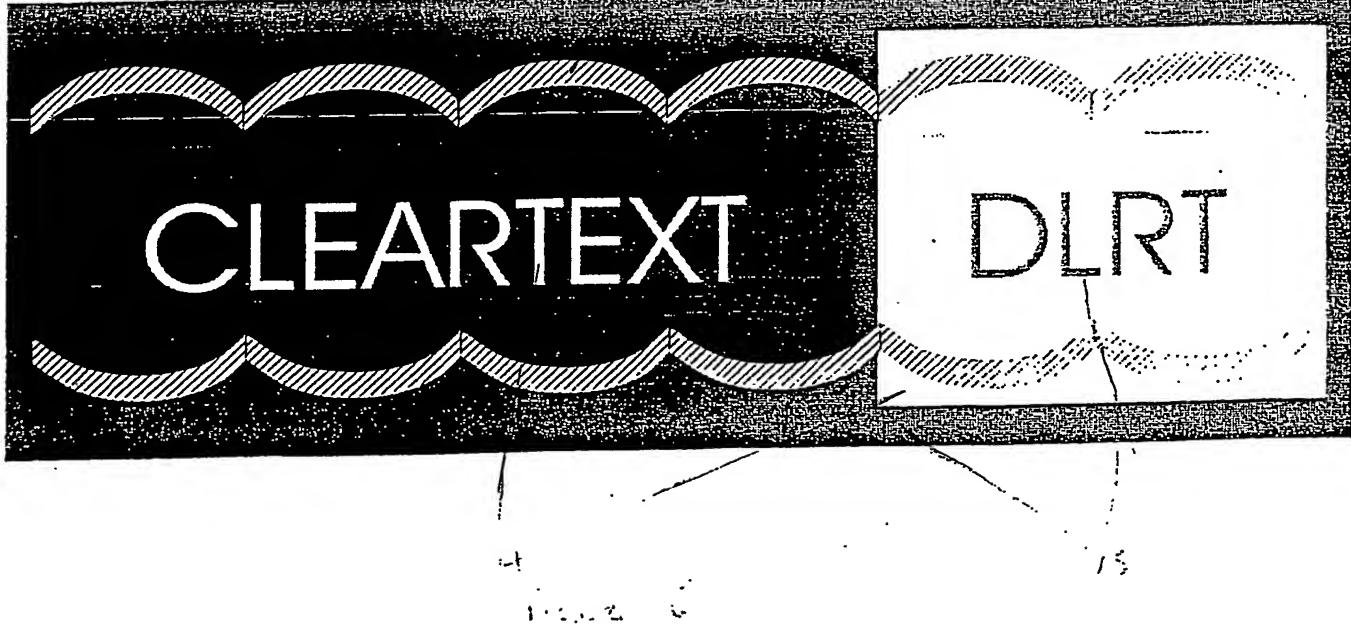


FIGURE 5



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